University of Nevada, Las Vegas Computer Science 456/656 Fall 2019

Assignment 4: Due Monday October 7, 2019

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. But the handwriting on this document must be your own. Print out the document, staple, and fill in the answers. You may attach extra sheets. Turn in the pages to the graduate assistant at the beginning of class, September 4. In each case, the identical problem is in both fifth and sixth editions.

1. Work Problem 6 on page 126 of the sixth edition of your textbook, which is problem 5 on page 126 of the fifth edition.

   (a)

   (b)

   (c)

   (d)

   (e)

   (f)

   (g)

2. Work Problem 22(a) on page 127 of the sixth edition of your textbook, which is problem 19(a) on page 127 of the fifth edition. Justify your answer.

3. We define a GRG, *generalized regular grammar* to consist of generalized productions of one of the following forms:

   $A \to rB$

   $A \to r$

   $A \to B$

   $A \to \lambda$

   where A and B are variables and r is a regular expression.

   True or false: Every language generated by a GRG is regular.

4. True or false: Every context-free language over the unary alphabet $\{1\}$ is regular. (Hint: Problem 3.)

5. Consider the "toy" programming language[1] P generated by the following context-free grammar, where the variables are S, L, the terminals are a, w, i, e, b, n and the productions are

$S \to a$
$S \to wS$
$S \to iS$
$S \to iSeS$
$S \to bLn$
$L \to SL$
$L \to \lambda$

(a) Find a rightmost derivation of $wbaiaewan$. (Leftmost and rightmost derivations are introduced on page 133 of the sixth edition of your textbook, and on page 132 of the fifth edition.)

(b) Show that the grammar is ambiguous by giving two different parse (derivation) trees for some string.

6. The following grammar unambiguously generates a language of algebraic expressions.

$E \to T$
$E \to E + T$
$E \to E - T$
$T \to F$
$T \to T * F$
$F \to -F$
$F \to I$
$F \to (E)$
$I \to x \mid y \mid z$

Using that grammar, construct parse (derivation) trees for each of the following strings.

$(x + y) * z + x$
$x * y + (y + z) * x$
$x - y - z * -x$

[1] Think of S = statement, a = assignment statement, w = while condition do, i = if condition do, e = else, b = begin or {, n = end or }, L = list of statements.

7. The definition of CNF, *Chomsky normal form*, in our textbook differs from the definition given in some other textbooks. We will use the definition given in our textbook. Under that definition, there is a CNF grammar for any CF language L provided $\lambda \notin L$.

   Give a CNF grammar for the language $L = \{a^n b^m \ : \ n = m + 1\}$.

8. True/False/Open: "Every context-free language is in the class $\mathcal{P}$-TIME." Justify your answer.